

REMARKS

Reconsideration of the application in light of the following remarks is respectfully requested.

Status of the Claims

Claims 1 – 22 are currently pending, with claims 23 and 24 having previously been canceled without prejudice or disclaimer. Claims 1 and 17 are amended. No new matter is introduced.

Rejection under 35 U.S.C. § 112

Claims 1 and 17 are rejected under the first paragraph of 35 U.S.C. § 112 as failing to comply with the written description requirement. Specifically, the Examiner finds that the limitation “the light emitting device emits light from a junction formed between the cathode and another element of the light emitting device” is not supported by the specification.

In the interests of prosecution efficiency, and without admitting the propriety of the present rejections under 35 U.S.C. § 112, Applicants amend claims 1 and 17 to revise this limitation as follows (for example, in amended independent claim 1):

1. A diamond electron emission device comprising a light emitting device for irradiating light to a cathode, wherein at least an electron emission face of said cathode is made of diamond and the light emitting device comprises a junction formed between the cathode and another element of the electron emission device.

(Emphasis added).

To satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. See, e.g., MPEP § 2163 (I), citing *Moba, B.V. v. Diamond Automation, Inc.*, 325 F.3d 1306, 1319, 66 USPQ2d 1429, 1438 (Fed. Cir. 2003); *Vas-*

Cath, Inc. v. Mahurkar, 935 F.2d at 1563, 19 USPQ2d at 1116. An applicant shows possession of the claimed invention by describing the claimed invention with all of its limitations using such descriptive means as words, structures, figures, diagrams, and formulas that fully set forth the claimed invention. See *Id.*, citing *Lockwood v. American Airlines, Inc.*, 107 F.3d 1565, 1572, 41 USPQ2d 1961, 1966 (Fed. Cir. 1997).

Applicants submit that the following portions of Applicants' specification and accompanying drawing figure, for example, sufficiently describe Applicants' invention as claimed for the purpose of complying with the first paragraph of 35 U.S.C. § 112, and in particular, the written description requirement:

The diamond electron emission device in the present invention has a light emitting device to illuminate light to a cathode, and at least one electron emission face of the cathode is made of diamond. Since this device has a light emitting device, electrons can be excited by light to a higher level than a conduction band 21 of the diamond which is higher than the vacuum level 25 as shown in FIG. 4. Therefore the voltage required to draw out electrons can be reduced greatly and thus a small electron emitting device, which may be operated at low voltage, can be obtained.

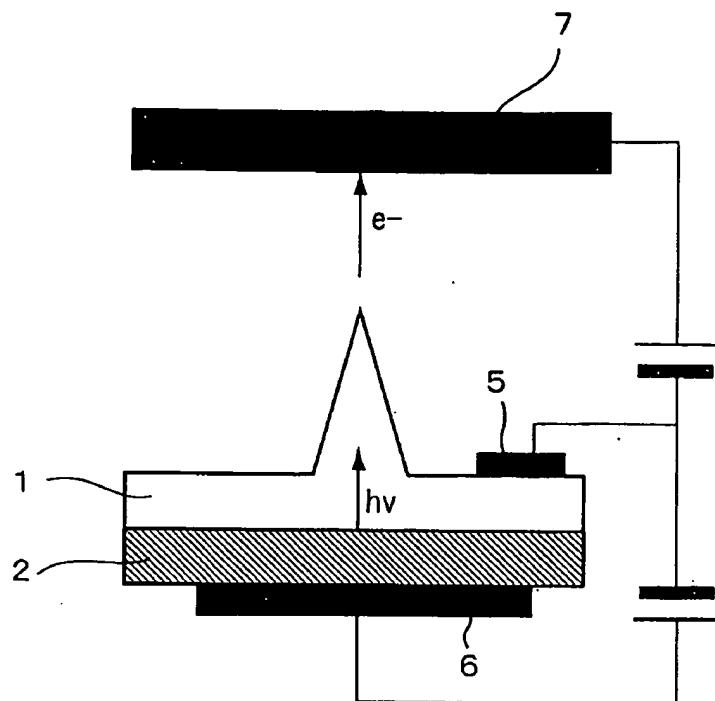
(page 2, line 23 through page 3, line 7, emphasis added).

... the light emitting device is preferably [a] pn junction of diamond. Since the light emitting device made of the pn junction diamond emits short wavelength light such as free exciton emission at 5.27 eV, the electron emission is facilitated. Also, using the same material as the cathode, it is easy to form the light emitting device and the cathode as one unit.

Furthermore, the light emitting device may be a schottky junction or MIS (Metal Insulator Semiconductor) structure of diamond and metal. Since the light emitted by schottky junction or MIS structure is in short wavelengths, electrons in deep levels can be excited and the electron energy after the excitation is high. Consequently the electron emission probability is high and emission of electron is facilitated.

(page 4, line 22 through page 5, line 4, emphasis added).

FIG. 1



The First Embodiment

N-type sulfur doped diamond is synthesized by the microwave plasma CVD method on a (100) face of a single crystal of a p-type diamond, which has been synthesized by the high temperature and high pressure method. The synthetic conditions are as follows: the temperature of the p-type diamond is 825 deg. Centigrade, methane/hydrogen concentration ratio is 1.0%, and hydrogen sulfide/methane concentration ratio is 1000 ppm. The n-type sulfur doped diamond is synthesized to 10 microns thick.

Next, a 1 micron thick Al film is formed by sputtering on the n-type sulfur doped diamond. The Al film is made into 5 micron dots by the photolithography and the wet etching methods, and then the sulfur doped diamond 1 is made into a projection form as shown in FIG. 1 by etching the sulfur doped diamond by the RIE method. After that the surface of the sulfur doped diamond is oxygen terminated by annealing at 400 deg. Centigrade for 30 min in the atmosphere.

Next, electrodes 5 and 6 are formed on the flat part of the sulfur doped diamond 1 and on the opposite side of the face where the sulfur doped diamond of p-type diamond 2 is formed. The procedure is as follows: [An] ion is injected to the diamond face on which an electrode is to be formed and diamond is changed to graphite, and then Ti/Au is evaporated while heating at 300 deg. Centigrade to form ohmic electrodes 5, 6.

...

At first, when increasing voltage is applied between the electrode 5 and the anode 7, the emission of electrons from the projection part of the diamond is detected from 1 kV. Next, when 10 V is applied between the electrodes 5 and 6, the light emission $h\nu$ from the pn junction layer is confirmed. The wavelength of this light is broad ranged but the main wavelengths are 235 nm for free exciton emission and band A emission centered at 430 nm.

(page 8, line 20 through page 10, line 3, emphasis added).

Applicants submit that the specification as excerpted above clearly describes a diamond electron emission device that includes a light emitting device for irradiating light to a cathode and having at least one emission face made of diamond. The specification describes several embodiments of the light emitting device that each comprise a junction (e.g., a pn junction or a schottky junction). The specification further describes an embodiment illustrated by FIG. 1 in which a pn junction is formed by synthesizing an n-type sulfur doped diamond by a microwave plasma CVD method on a face of a single crystal p-type diamond. As illustrated in FIG.1, the junction is formed between the cathode 1 and “another element” (i.e., the p-type diamond 2) of the diamond electron emission device. In the embodiment of FIG. 1, the light emitting device (pn junction) emits light of “broad ranged” wavelengths, including a “band A emission centered at 430 nm” (i.e., light in the visible spectrum).

Accordingly, Applicants respectfully submit that each of the elements of amended independent claim 1 is clearly and adequately supported by the specification, and that amended independent claim 1 therefore satisfies the requirements of the first paragraph of 35 U.S.C. § 112. Applicants further submit that amended independent claim 17, which includes the same above-supported limitations, also satisfies the requirements of the first paragraph of 35 U.S.C. § 112.

Claims 1 - 22 are rejected under the second paragraph of 35 U.S.C. § 112 as being indefinite. Specifically, the Examiner finds that independent claims 1 and 17 are indefinite with respect to the claim element “another element of the light emitting device,” which together with a claimed cathode defines a claimed junction of the claimed diamond electron emission device.

In the interests of prosecution efficiency, and without admitting the propriety of the present rejections under 35 U.S.C. § 112, Applicants amend claims 1 and 17 to recite “another element of the electron emission device” (emphasis added). As shown above for example in Applicants’ FIG.1, which illustrates an embodiment of the claimed invention, the claimed junction is formed between a cathode 1 (an n-type diamond) and “another element” of the electron emission device as presently claimed. (i.e., a p-type diamond 2). In another embodiment as shown in FIG. 3, the cathode 2 comprises a p-type diamond while the “other element” comprises an n-type diamond. As claimed, the “other element” is an element that forms a junction together with a cathode having at least an electron emission face made of diamond, where the junction defines a light emitting device of the claimed diamond electron emission device.

Accordingly, Applicants respectfully submit that each of the elements of amended independent claim 1 is clearly recited, and amended independent claim 1 therefore satisfies the requirements of the second paragraph of 35 U.S.C. § 112. Applicants further submit that amended independent claim 17, which includes the same above-supported limitations, and claims 2 – 16 and 18 – 22, which each depend from one of amended independent claims 1 and 17, also satisfy the requirements of the second paragraph of 35 U.S.C. § 112.

Therefore, Applicants respectfully request that the rejections of independent claims 1 and 17 under the first and second paragraphs of 35 U.S.C. § 112 be withdrawn.

CONCLUSION

Each and every point raised in the Office Action mailed June 15, 2009 has been addressed on the basis of the above amendments and remarks. In view of the foregoing it is believed that claims 1 - 22 are in condition for allowance, and it is respectfully requested that the application be reconsidered and that all pending claims be allowed and the case passed to issue.

If there are any other issues remaining which the Examiner believes could be resolved through a Supplemental Response or an Examiner's Amendment, the Examiner is respectfully

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Respectfully submitted,

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